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[10537/94]

ARRANGEMENT OF A RUNNING ROLLER ON A COUPLING JOURNAL OF A MOVEABLE SHAFT COUPLING

FIELD OF THE INVENTION

The invention relates to an arrangement of a running roller on a coupling journal of a moveable shaft coupling.

BACKGROUND INFORMATION

In shaft couplings with a conventional arrangement of a running roller, it is essential that the two shafts to be coupled are capable, in relation to one another, of assuming "bending positions" of a static or dynamic type with respect to their axes of rotation and of executing axial movements, without non-uniformities in the rotational speed behaviour occurring on the shafts.

In another arrangement of the running roller as described, for example, in German Published Patent Application No. 28 31 044, the connection of the inner ring of the rolling bearing to the associated ball socket of the ball joint is configured so that the inner ring and ball joint are produced in one piece, while, in order to maintain the additional degree of freedom of the cylindrical coupling journal in relation to the complementary coupling half, the coupling journal is connected to the ball head, associated with it, of the ball joint, so as to be axially displaceable with respect to its geometric major axis, but radially immovably, so that the joint center consequently always coincides with the geometric major axis of the coupling journal. The sliding movements of the coupling journal in relation to the associated ball head, require a costly grinding or honing process in order to produce the relevant sliding faces, without it being possible to avoid completely the excitation of vibrations as a result of frictional resistances or power losses.

In another arrangement of a running roller on a coupling journal of a moveable shaft coupling, as described, for

example in European Published Patent Application No. 0 426 186, the above-described disadvantages of the conventional arrangement are to be eliminated in that the inner recess, receiving the ball head, of the inner ring of the rolling bearing, is cylindrical and the ball head fixedly connected to the coupling journal is displaceable in the cylindrical inner recess radially (i.e., in the directions of the bearing axis of the rolling bearing). Thus, in this arrangement, the entire coupling moment introduced into the coupling journal is transmitted to the cylindrical face of the inner ring in a virtually pointing and sliding manner at that point on the ball face which is also exposed to the sliding displacement of the coupling journal in the directions of the bearing axis and therefore to sliding resistance during its relative movements in relation to the complementary coupling half.

It is an object of the present invention to provide an arrangement of a running roller on a coupling journal of a moveable shaft coupling, in which the vibrational excitations in the shafting which originate from frictional resistances between faces which are in sliding contact with one another are reduced.

SUMMARY

The above and other beneficial objects of the present invention are achieved by providing an arrangement as described herein.

In one example embodiment of the arrangement of a running roller according to the present invention, both axial sliding movements of the coupling journal in relation to the ball head and axial sliding movements of the ball head in relation to the inner ring are positively prevented, and, furthermore, a fraction of the relative movement necessary for maintaining the additional degree of freedom for the coupling journal in relation to the complementary coupling half is absorbed into the rolling bearing as a rolling movement of the rolling bodies. This arrangement results in a reduction in the

sliding fraction of the relative movement and therefore results in a reduction in the vibrational excitation and power losses.

In the arrangement according to the present invention, the coupling journal may be connected, for example, to that joint half of the ball joint which has the concave ball face.

In the arrangement according to the present invention, the need for a separate individual joint part for the ball head may be eliminated.

In another example embodiment of the arrangement according to the present invention, it is possible to insert the ball head of the coupling journal either directly into the central orifice of the inner ring or into the central orifice of a fixing insert and to implement the axial securing of the ball head by one or two fixing inserts.

According to yet another example embodiment of the arrangement according to the present invention, the functions of the rolling-bearing-side joint half of the ball joint and of the axial fixing of said joint half in the directions of the bearing axis of the rolling bearing are integrated into the fixing insert which can be produced in its configuration by a non-fixing hobbing method, so that there is no need for cost-intensive grinding methods and the like in order to produce the joint face, in particular the ball face of this component in the arrangement according to the present invention.

In still another example embodiment of the arrangement according to the present invention, using a fixing insert, the element for configuring the joint portion and the element for fixing the complementary joint half of the coupling journal may be produced in one piece.

In a further example embodiment of the arrangement according to the present invention, using a fixing insert, the fixing insert may be secured, for example, in relation to the inner ring of the rolling bearing, in each case in one directions of the bearing axis, by a collar or by a securing ring.

The rolling bearing may be configured as a loose bearing in order to maintain the additional degree of freedom of the coupling journal for the relative movements of the latter in relation to the complementary coupling half.

The rolling bearing may also be configured with a thrust washer for the rolling bodies.

The number of individual components in the arrangement according to the present invention in the example embodiment that includes thrust washers used for the rolling bodies may be reduced.

The rolling bearing may be configured as a loose bearing for maintaining the additional degree of freedom of the coupling journal for the relative movement of the latter in relation to the complementary coupling half.

In another example embodiment of the arrangement of a running roller on a coupling journal according to the present invention, the formation of a special middle joint portion on a fixing insert is eliminated, and, instead, in each case a simple fixing insert is used for the fixing, in each case in one of the directions of the bearing axis, of the ball head of the coupling journal, the ball head at the same time being inserted directly into the central orifice of the inner ring of the rolling bearing.

BRIEF DESCRIPTION OF THE DRAWINGS

Figure 1 is an axial cross-sectional view through a moveable shaft coupling with an arrangement of a running roller on a coupling journal of one coupling half according to the present invention, in a first example embodiment depicted in a bending position of the coupling in a plane containing both the axis of the coupling journal and the central axis of the complementary coupling half.

Figure 2 is, in the upper half, an axial cross-sectional view through the running roller according to the present invention in the first example embodiment illustrated in Figure 1, depicted rotated clockwise through 90°, and, in the lower half, a view, corresponding to that of the upper half,

of the arrangement of the running roller according to the present invention in the first example embodiment illustrated in Figure 1, but in which the coupling is in the straight position.

Figure 3 is a view, corresponding to that illustrated in Figure 2, of a coupling illustrated in Figure 1 with an arrangement of the running roller according to the present invention in a third example embodiment which is illustrated and described in more detail with reference to Figure 5.

Figures 4 and 4a are axial cross-sectional views through the shaft coupling illustrated in Figure 1, in the straight position, taken along the line IV-IV, in which Figure 4 illustrates the first example embodiment of the arrangement according to the present invention in the left half of the section and Figure 4a illustrates a second example embodiment of the arrangement according to the present invention in the right half of the section.

Figures 5 and 5a are axial cross-sectional views which correspond to those of Figures 4 and 4a and in which Figure 5 illustrates a third example embodiment of the arrangement according to the present invention in the left half of the section and Figure 5a illustrates a fourth example embodiment of the arrangement according to the present invention in the right half of the section.

Figures 6 and 6a are axial cross-sectional views which correspond to those of Figures 4 and 4a and in which Figure 6 illustrates a fifth example embodiment of the arrangement according to the present invention in the left half of the section and Figure 6a illustrates a sixth example embodiment of the arrangement according to the present invention in the right half of the section.

Figures 7 and 7a are axial cross-sectional views which correspond to those of Figures 4 and 4a and in which Figure 7 illustrates a seventh example embodiment of the arrangement according to the present invention in the left half of the section and Figure 7a illustrates an eighth example embodiment

of the arrangement according to the present invention in the right half of the section.

Figures 8 and 8a are axial cross-sectional views which correspond to those of Figures 4 and 4a and in which Figure 8 illustrates a ninth example embodiment of the arrangement according to the present invention in the left half of the section and Figure 8a illustrates a tenth example embodiment of the arrangement according to the present invention in the right half of the section.

Figures 9 and 9a are axial cross-sectional views which correspond to those of Figures 4 and 4a and in which Figure 9 illustrates an eleventh example embodiment of the arrangement according to the present invention in the left half of the section and Figure 9a illustrates a twelfth example embodiment of the arrangement according to the present invention in the right half of the section.

Figures 10 and 10a are axial cross-sectional views through the fixing insert, depicted as an individual part, of the fifth example embodiment of the arrangement according to the present invention, as illustrated in Figure 6.

Figure 11 is an axial cross-sectional view through the shaft coupling illustrated in Figure 1, in the straight position, taken along the line XI-XI, with the arrangement of the running roller according to the present invention in a thirteenth example embodiment.

DETAILED DESCRIPTION

Referring first to Figures 1, 2 and 4, a moveable shaft coupling 21 is used for the rotationally fixed connection of two drive shafts 75 and 76 which with respect to their central axes 39-39 and 55-55 may assume a bending position forming a bending angle 77 or a straight position with their central axes being aligned coaxially.

That coupling half 18 of the shaft coupling 21 which is assigned fixedly in terms of movement to the drive shaft 75 includes at least one coupling journal 17 which is oriented with its central axis 74-74 perpendicular to the central axis

39-39 of the drive shaft 75 and which is connected rotationally and pivotably movably to a running roller 15 by a series arrangement that includes a ball joint 38 and a radial rolling bearing 35.

The complementary coupling half assigned fixedly in terms of movement to the drive shaft 76 is configured as a coupling drum 20 which has on its inner circumference, for each running roller 15, an axial groove 78 which is open to the inner circumference and of which the mid-plane contains the central axis 55-55 and of which the groove side faces, which are used as counterrunning faces 26 and 27 for the running roller 15, in each case run parallel to and are oriented symmetrically to this mid-plane.

The running roller 15 is provided on its outer circumference with a roof-shaped running face 23 which is concentric to a central axis 22-22 of said running roller and which can roll in torque-transmitting bearing contact on one of the two matching counterrunning faces 26, 27.

The running roller 15 is produced on its inner circumference in one piece with a cylindrical outer running face 32, concentric to the central axis 22-22 of said running roller, for the rolling bodies 33 (e.g., needles) of the rolling bearing 35.

When the coupling 21 is in the bending position, to maintain an additional degree of freedom F for the relative movements of the coupling journal 17 perpendicularly to the central axis 55-55 of the complementary coupling half 20, the rolling bearing 35 is configured as a loose bearing. This is achieved, in that the rolling bodies 33 are arranged movably in relation to their outer running face 32 in the directions of the bearing axis 34-34 which coincides with the central axis 22-22 of the running roller 15 in the installed position.

The rolling bearing 35 includes an inner ring 37 which is provided on its outer circumference with a cylindrical inner running face 36 for the rolling bodies 33 which is concentric to the bearing axis 34-34. The rolling bodies 33 are fixed immovably in relation to the inner running face 36 in the

directions of the bearing axis 34-34, in each case by a thrust washer 64.

The thrust washers 64 are configured as a radial widening of a radial collar which is provided as a respective axial insertion end 12 and 13, extending coaxially to the bearing axis 34-34, of a sleeve-shaped fixing insert 46 and which is produced in one piece with said fixing insert. The fixing insert 46 is inserted positively and fixedly in terms of movement into the central orifice 58 of the inner ring 37, the central orifice being configured cylindrically and centrally to the bearing axis 34-34, the respective collar 64 securing the fixing insert 46 in relation to the inner ring 37 in the direction, pointing toward the inner ring 37, of a central axis 59-59 of a fixing insert 46, the central axis coinciding with the bearing axis 34-34 in the installed position. The fixing insert 46 includes, in its axially middle region, a joint portion 60 which, with its concave spherical inner generated surface 61, is configured as that joint part of the ball joint 38 which is assigned fixedly in terms of movement to the inner ring 37 and which receives the ball head 56 which has the convex ball face 57 and which is used as the joint half assigned fixedly in terms of movement to the coupling journal 17. The fixing insert 46 includes a cross-sectional shaping 14 which is provided axially between a collar 64 and a joint portion 60 and which projects centripetally in relation to the central orifice 58 of the inner ring 37 so that the ball head 56 is fixed immovably in relation to the inner ring 37 in the respective direction of the bearing axis 34-34 which points from the joint portion 60 toward the cross-sectional shaping 14. The inner generated surface 61 of the joint portion 60 and the inner generated surfaces of the cross-sectional shapings 14 merge continuously into one another to form a concave spherical overall surface. The cross-sectional shapings 14 thus ensure that the joint center 54 of the ball joint 38 remains fixed invariably in position in relation to the fixing insert 46 in the direction of the

central axis 59-59 of the fixing insert 46, even when the shaft coupling 21 is in the bending positions.

The second example embodiment of the arrangement of a running roller according to the present invention, as illustrated in Figure 4a, differs from the first embodiment illustrated in Figure 4 in that a fixing 47 is used, the middle joint portion 60 of which is designed cylindrically, that is to say has an outer cylindrical generated surface 70, concentric to its central axis 59-59, for its positive insertion into the central orifice 58 of the inner ring 37 and an inner cylindrical generated surface 62 concentric to its central axis 59-59, for receiving the ball head 56 of the coupling journal 17. By virtue of this cylindrical design, as a further difference from the first example embodiment illustrated in Figure 4, the cross-sectional shapings 19 extending axially between the joint portion 60 and a collar 64 and intended for fixing the ball head 56 axially are configured in the form of an annular bead concentric to the central axis 59-59. The two example embodiments are otherwise identical, so that the same reference numerals are used for coinciding features and reference may be made to the description of the example embodiment illustrated in Figure 4.

The third example embodiment of the arrangement of a running roller 16 according to the present invention is illustrated in Figures 3 and 5. The third example embodiment differs from the first example embodiment illustrated in Figure 4 in that a fixing insert 50 for the inner ring 37 is used, in which the radial collar 65 provided on one of the insertion ends 12 and 13 extending coaxially to the central axis 59-59 of the fixing insert is configured both to form a thrust washer for the rolling body 33 of the rolling bearing 35 and, in a radial widening, to form an axial bearing disc for fixing the running roller 16 in relation to the inner ring 37 in the directions of the bearing axis 34-34. The rolling bearing 35 defines a fixed bearing for the running roller 16 also in relation to the joint center 54 of the ball joint 38 and consequently also in relation to the coupling journal 17.

When the coupling 21 is in the bending position, to maintain an additional degree of freedom F for the relative movements of the coupling journal 17 perpendicularly to the central axis 55-55 of the complementary coupling half 20, the running face 25 of the running roller 16 is configured cylindrically, and the counterrunning faces 30 and 31 of the axial groove 78 extend in a plane of the complementary coupling half 20.

The first and third example embodiments of the present invention are otherwise identical, so that the same reference numerals are used for coinciding features and reference may be made to the description of the example embodiment illustrated in Figure 4.

The fourth example embodiment of an arrangement of a running roller 16 according to the present invention, as illustrated in Figure 5a, differs from the third example embodiment, only in that a fixing insert 51 with a middle cylindrical joint portion 60 joined with end cross-sectional shapings 19, each in the form of an annular bead, is configured and used in the same way as the fixing insert 47 in the second example embodiment illustrated in Figure 4a, so that the same reference numerals are provided for coinciding features and reference may be made to the description of the example embodiment illustrated in Figure 4a.

The fifth example embodiment of the arrangement of the running roller 15 according to the present invention, as illustrated in Figure 6, differs from the first example embodiment illustrated in Figure 4 in that a fixing insert 40 is provided, which is secured by its respective end collar 63 in relation to the inner ring 37 in the directions of the bearing axis 34-34. The rolling bodies 33 are fixed immovably in relation to their outer running face 32 on the running roller 15 in the directions of the bearing axis 34-34.

When the coupling 21 is in the bending position, to maintain an additional degree of freedom F for the relative movement of the coupling journal 17 perpendicularly to the central axis 55-55 of the complementary coupling half 20, a

rolling bearing 35 is configured as a loose bearing. Thus, the rolling bodies 33 are arranged movably in relation to their inner running face 36 on the inner ring 37 in the directions of the bearing axis 34-34.

The first and fifth example embodiments of the present invention are otherwise identical, so that the same reference numerals are provided for coinciding features and reference may be made to the description of the example embodiment illustrated in Figure 4.

The sixth example embodiment of the arrangement of the running roller 15 according to the present invention, as illustrated in Figure 6a, differs from the fifth example embodiment, only in that a fixing insert 41 is used, in which, as in the second example embodiment illustrated in Figure 4a, the middle joint portion 60 is configured cylindrically and the cross-sectional shapings 19 are each configured in the form of an annular bead. The fifth and sixth example embodiments of the present invention are otherwise identical, so that the same reference numerals are used for coinciding features and reference may be made to the description of the example embodiments illustrated in Figures 4a and 6.

The seventh example embodiment of the arrangement of the running roller 15 according to the present invention, as illustrated in Figure 7, differs from the first example embodiment of the present invention illustrated in Figure 4 merely in that the rolling bodies 33 are fixed immovably, in the direction of the bearing axis 34-34 pointing from the joint portion 60 toward one insertion end 12 of the fixing insert 42 by a separate thrust washer 67 which is supported in this direction on the respective collar 63 of the fixing insert 42 via a securing ring 66 seated on this insertion end 12.

The first and seventh example embodiments of the present invention illustrated in Figures 4 and 7 are otherwise identical, so that the same reference numerals are used for coinciding features and reference may be made to the

description of the example embodiment of the present invention illustrated in Figure 4.

The eighth example embodiment of the arrangement of the running roller 15 according to the present invention, as illustrated in Figure 7a, differs from the seventh example embodiment of the present invention, only in that, as in the second example embodiment of the present invention illustrated in Figure 4a, a fixing insert 43 with a cylindrical joint portion 60 and with cross-sectional shapings 19 configured in the form of an annular bead is used.

The seventh and eighth example embodiments of the present invention are otherwise identical, so that the same reference numerals are used for coinciding features and reference may be made to the descriptions of the example embodiments illustrated in Figures 4a and 7.

The ninth example embodiment of the arrangement of the running roller 15 according to the present invention, as illustrated in Figure 8, differs from the seventh example embodiment illustrated in Figure 7 merely in that the rolling bodies 33 are fixed immovably in relation to the inner ring 37, by a thrust washer 67, in the other direction of the bearing axis 34-34, pointing from the joint portion 60 toward the insertion of the end 13 of the fixing insert 44, both thrust washers 67 being axially supported directly on the respectively adjacent collar 63 of the fixing insert 44.

The seventh and ninth example embodiments of the present invention illustrated in Figures 7 and 8 are otherwise identical, so that the same reference numerals are used for coinciding features and reference may be made to the description of the example embodiment of the present invention illustrated in Figure 7.

The tenth example embodiment of the arrangement of the running roller 15 according to the present invention, as illustrated in Figure 8a, differs from the ninth example embodiment illustrated in Figure 8, only in that, in the former, a fixing insert 45 is used in which, as in the second example embodiment illustrated in Figure 4a, the middle joint

portion 60 is configured cylindrically and the contiguous cross-sectional shapings 19 are each configured in the form of an annular bead.

The tenth and ninth example embodiments are otherwise identical, so that the same reference numerals are used for coinciding features and reference may be made to the descriptions of the example embodiments illustrated in Figures 4a and 8.

The eleventh example embodiment of the arrangement of the running roller 16 according to the present invention, as illustrated in Figure 9, differs from the third example embodiment illustrated in Figure 5, merely in that, in the former, use is made of a thrust washer 68 which is separate from the respective collar 63 of the fixing insert 48 and is widened radially to form an axial bearing washer for fixing the running roller 16 in relation to the inner ring 37 in the direction of the bearing axis 34-34 and which is supported axially on the adjacent collar 63. The third and eleventh example embodiments are otherwise identical, so that the same reference numerals are used for coinciding features and reference may be made to the description of the example embodiment illustrated in Figure 5.

The twelfth example embodiment of the arrangement of the running roller 15 according to the present invention, as illustrated in Figure 9a, differs from the eleventh example embodiment illustrated in Figure 9, only in that, in the former, a fixing insert 49 is used, in which, as in the second example embodiment illustrated in Figure 4a, the middle joint portion 60 is configured cylindrically and the contiguous cross-sectional shapings 19 are each configured in the form of an annular bead.

The eleventh and twelfth example embodiments of the present invention are otherwise identical, so that the same reference numerals are used for coinciding features and reference may be made to the descriptions of the example embodiments of the present invention illustrated in Figures 4a and 9.

The thirteenth example embodiment of the arrangement of the running roller 15 according to the present invention, as illustrated in Figure 11, differs from the fifth example embodiment illustrated in Figure 6, in that, in the former, in addition to the convex and therefore different spherical design of the outer running face 24, it is essential that the ball head 56 is inserted pivotally movably with its convex ball face 57 directly into the cylindrical central orifice 58 of the inner ring 37 and be fixed immovably in relation to the inner ring 37 in the directions of the bearing axis 34-34 by a fixing insert 52 or 53 configured in the form of a securing ring. Apart from the fact that the counterrunning faces 28 and 29 of the complementary coupling half 20 are configured concavely in the form of an arc of a circle in cross-section so as to match the running face 24, the fifth and thirteenth example embodiments of the present invention are otherwise identical, so that the same reference numerals are used for coinciding features and reference may be made to the description of the example embodiment illustrated in Figure 6.

Referring to Figures 10 and 10a, in the fifth example embodiment of the arrangement of the running roller 15 according to the present invention, as illustrated in Figure 6, a slotted design of the fixing insert 40 is provided. Accordingly, this fixing insert 40 includes, at its insertion end 13 extending coaxially to its central axis 59-59, slots 69 which are closed off on one side and which are arranged so as to be distributed uniformly over the circumference and are open both to the end face of the insertion end 13 and to the inner generated surface 61 and also to the outer generated surface 70 of the latter. The closed slot ends of the slots 69 are arranged in a plane 72-72 which is perpendicular to the central axis 59-59 and which intersects the fixing insert 40 as a transition between the cross-sectional shaping 14 adjacent to the insertion end 13 and the joint portion 60.

The fixing insert 40 is separated radially by a separating slot 73 which extends obliquely to the central axis 59-59 and which extends, continuously open, onto the end faces

of the insertion ends 12 and 13 arranged coaxially to the central axis.

The above-described slotted configuration of the fixing insert 40 may also be adopted in one or more or in all of the above-described fixing inserts 41 to 51.

Using a slotted fixing insert, as described above, the procedure for assembling the arrangement of the running roller according to the present invention, for example in the fifth example embodiment illustrated in Figure 6, may be such that, first, the running roller 15, the rolling bearing 35 and the fixing insert 40 are joined together to form a pre-assembled structural unit, with the slotted fixing insert 40 being clamped together radially when being inserted into the central orifice 58 of the inner ring 37. The structural unit produced in this manner may then be substantially snapped onto the ball head 56 of the coupling journal 17, with the slotted insertion end 13 of the fixing insert 40 in front.

In applications in which it is considered advantageous to use a non-slotted version of a fixing insert, the fixing insert, when being produced, may be brought, for the purpose of subsequent assembly of the arrangement of the running roller according to the present invention, into an intermediate form, in which at least one region proportionately including the joint portion and an insertion end extending coaxially to the central axis is still arranged in a straight initial state. The procedure for assembling the arrangement of the running roller according to the present invention may be such that a fixing insert, in its intermediate form, a running roller and the rolling bearing are joined together to form a pre-assembled structural unit. The ball head of the coupling journal may then be introduced into the fixing insert via the central orifice of the straight region of the intermediate form. With the ball head inserted, the straight region of the intermediate form may then be deformed plastically into its ultimate desired shape.

In all of the example embodiments of the arrangement of the running roller according to the present invention, it may

be advantageous for a fraction of the relative movements of the coupling journal 17 in relation to the complementary coupling half 20 in the directions perpendicular to the central axis 55-55 of the latter to occur as a rolling movement in the rolling bearing and for no concave ball faces to have to be machined on the ball joint 38 by grinding. The respective fixing insert 40 to 51 provided with a joint portion 60 may be produced as a whole, together with its joint faces, by rolling, whereas, in the thirteenth example embodiment of the present invention illustrated in Figure 11, with regard to the ball joint 38, neither concave ball faces are present nor axial sliding movements of the ball head 56 relative to the central orifice 58 of the inner ring 37 occur in the directions of the bearing axis 34-34.